

CLAIMS

1. A system and a method for providing comprehensive fire prevention and suppression in different compartments of an aircraft by producing oxygen-depleted or hypoxic air from a bleed air, said system comprising:
 - 5 an air-separation device receiving said bleed air from an aircraft engine and using its pressure and flow, as a driving force, for separating it into oxygen-enriched and oxygen-depleted gas mixtures;
said oxygen-enriched gas mixture being normally vented outside the aircraft or, in case of an emergency, supplied to passengers and the crew via respiratory masks;
 - 10 said oxygen-depleted gas mixture being constantly supplied into fuel tanks for maintaining there a hypoxic environment in order to prevent a fuel ignition; the oxygen content in said environment is maintained below 12% and, preferably, at 10%;
said oxygen-depleted gas mixture being selectively supplied into cargo compartments of the aircraft establishing there a constant fire-preventive atmosphere or emergency fire-suppression
 - 15 environment, depending on design or situation; The oxygen content in said fire-preventive atmosphere being maintained in the range from 12% to 16% and from 8% to 12% in said emergency fire-suppression environment;
an optional pressurized container having sufficient amount of said hypoxic air in order to accelerate the flooding of the passenger cabin and the formation there a breathable fire-
 - 20 extinguishing atmosphere in a case of a fire;
said breathable fire-extinguishing atmosphere being established and maintained for as long as needed by supplying a sufficient flow of the oxygen-depleted gas mixture from said air-separation device; the oxygen content in said breathable fire-extinguishing atmosphere is maintained in the range from 12% to 16%;
 - 25 a mixing device for providing, when needed, the mixing of said oxygen-depleted gas mixture with said bleed air in order to increase and regulate the oxygen content in the cabin and different compartments of the aircraft;
a smoke and fire detection system with sensors installed in every compartment throughout the whole aircraft's interior;

an oxygen content monitoring system providing the oxygen content data in different compartments;
a computerized control panel for receiving and analyzing data from the smoke and fire detection and oxygen monitoring systems and regulating, when needed, the oxygen content in protected
5 compartments by releasing, increasing or decreasing the flow of said oxygen-depleted gas mixture or by altering its mixing ratio with air.

2. The system and method according to claim 1, wherein
a hypoxic gas mixture from said mixing device is supplied in amount equal or larger than the
10 leakage rate from the protected compartment allowing to maintain the designed oxygen content by ventilating the compartment with said hypoxic mixture.

3. The system and method according to claim 1, wherein
said mixing device is eliminated and said oxygen-depleted gas mixture is supplied directly
15 into protected compartment allowing to achieve and maintain the designed oxygen content by diluting the compartment's internal atmosphere.

4. The system and method according to claim 1, wherein
said oxygen-depleted gas mixture propels water through a special nozzle for generating
20 water mist inside the protected compartment.

5. The system and method according to claim 1, wherein
said oxygen-depleted gas mixture propels a foam generating solution through a special
device for generating hypoxic foam inside the protected compartment.

25 6. The system and method according to claim 1, wherein
said air-separation device is made of multiple oxygen-separation membranes connected parallel in one unit, so a failure of one membrane does not affect significantly the performance of the whole device.

30 7. The system and method according to claim 1, wherein

said air-separation device is made of multiple pressure-swing adsorption units connected parallel in one module, so a failure of one unit does not affect significantly the performance of the whole device.

- 5 8. The system and method according to claim 1, wherein
said air-separation device is a cryogenic unit producing nitrogen and oxygen from air and
said oxygen-depleted gas mixture is made by mixing nitrogen with the bleed air.
- 10 9. A method and a system for extinguishing fires using water mist propelled by hypoxic air,
said system and method comprising:
an air-separation device providing hypoxic air in amount and under pressure sufficient for
propulsion of water through a water mist generating nozzle;
a water tank for supplying the system with water propelled by said hypoxic air;
a water mist generating nozzle producing water mist propelled by hypoxic air;
15 said hypoxic or oxygen-depleted air having an oxygen content in the range from 8% to 15%
or 1%-8% in special cases;
when deployed, said system generates and releases water mist inside a protected area, said
water mist propelled by said hypoxic air that simultaneously gradually dilutes the internal
atmosphere and decreases its oxygen content to the fire extinguishing level;
20 the oxygen content in said hypoxic air propelling water mist being below 16% and,
preferably in the range from 8% to 12%;
the amount of water in said water tank being calculated to be sufficient to produce water mist
for the period of time needed to establish said fire-extinguishing level;
said method and system designated for extinguishing fires in aircraft, marine vessels,
25 buildings, all type of vehicles and other enclosed and semi-enclosed structures.
10. A method and a system for extinguishing fires using a foam propelled by hypoxic air,
said system and method comprising:
an air-separation device providing hypoxic air in amount and under pressure sufficient for
30 propulsion and production of a hypoxic foam;

a tank for storing and supplying the system with a foam generating solution propelled by said hypoxic air;
a foam generating device or nozzle producing said foam with hypoxic air;
said hypoxic or oxygen-depleted air having an oxygen content in the range from 8% to 15%
5 or 1%-8% in special cases;
when deployed, said system generates and releases the hypoxic foam inside a protected area simultaneously with said hypoxic air that gradually dilutes the internal atmosphere and decreases its oxygen content to the fire extinguishing level;
the oxygen content in said hypoxic air producing and propelling said foam being below 16%
10 and, preferably in the range from 8% to 12%;
the amount of the foam generating solution in said tank being calculated to be sufficient to produce said foam for the period of time needed to establish said fire-extinguishing level;
said method and system designated for extinguishing fires in aircraft, marine vessels, buildings, all type of vehicles and other enclosed and semi-enclosed structures.

15 11. A method and a system for providing oxygen enriched air for respiration in emergency onboard of an aircraft, said method and system comprising:
an air-separation device receiving said bleed air from an aircraft engine and using its pressure and flow, as a driving force, for separating it into oxygen-enriched and oxygen-depleted gas
20 mixtures;
said oxygen-enriched gas mixture, being normally vented outside the aircraft or used by the engine, is supplied in case of an emergency to passengers and a crew via respiratory masks;
the system is automatically deployed when a signal from smoke and fire detection system received or a pressure transducer detects a depressurization of the cabin.

25 12. A method of extinguishing fires in aircraft, marine vessels and other vehicles, buildings and tunnels, said method comprising:
a dilution of the atmosphere in the protected space with hypoxic air until a fire-extinguishing atmosphere is created;
30 a maintaining said fire-extinguishing atmosphere at a designed oxygen content level for as long as needed by ventilating said protected space with a sufficient flow of the hypoxic air.

13. A fire-extinguishing composition, said composition comprising:
a mixture of water mist and hypoxic air; said mixture being generated by propulsion of water
through a special mist generating nozzle using hypoxic air;
5 said mixture, propelled with said hypoxic air, being released into protected area, which
allows to rapidly control a fire before the necessary dilution of the internal atmosphere with
hypoxic air is achieved.

14. A fire-suppression composition, said composition comprising:
10 a mixture of foam and hypoxic air; said mixture being generated by propulsion of a foam
generating solution through a special foam generating device that produces said foam using
hypoxic air;
said foam, propelled further with said hypoxic air, being released into protected area, which
allows to rapidly control a fire before the necessary dilution of the internal atmosphere with
15 hypoxic air is achieved.

15. The system and method according to claim 14, wherein
said foam is made from a standard fire-extinguishing foam solution normally made and
propelled using ambient air or nitrogen.

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